Upcoming TFM Enhancements:
The Role of Simulation

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Presentation to: TFM in Fast-Time Simulation

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Agenda

- Upcoming TFM Enhancements
  - TFM Modernization (TFM-M)
  - Collaborative Air Traffic Management Technologies (CATMT) Work Package 1
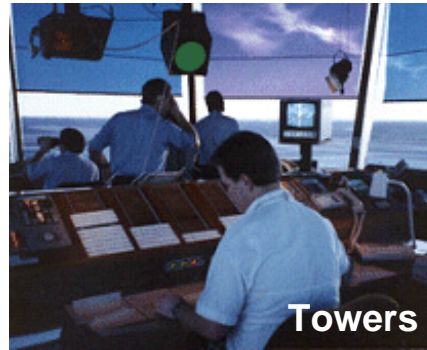- Simulation – Before, During, & After Implementation of TFM Enhancements
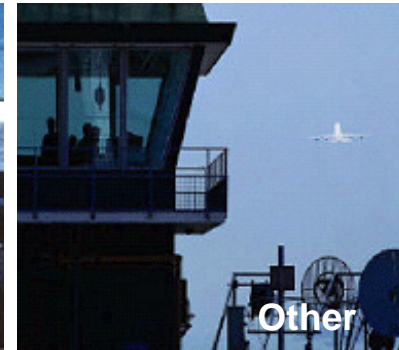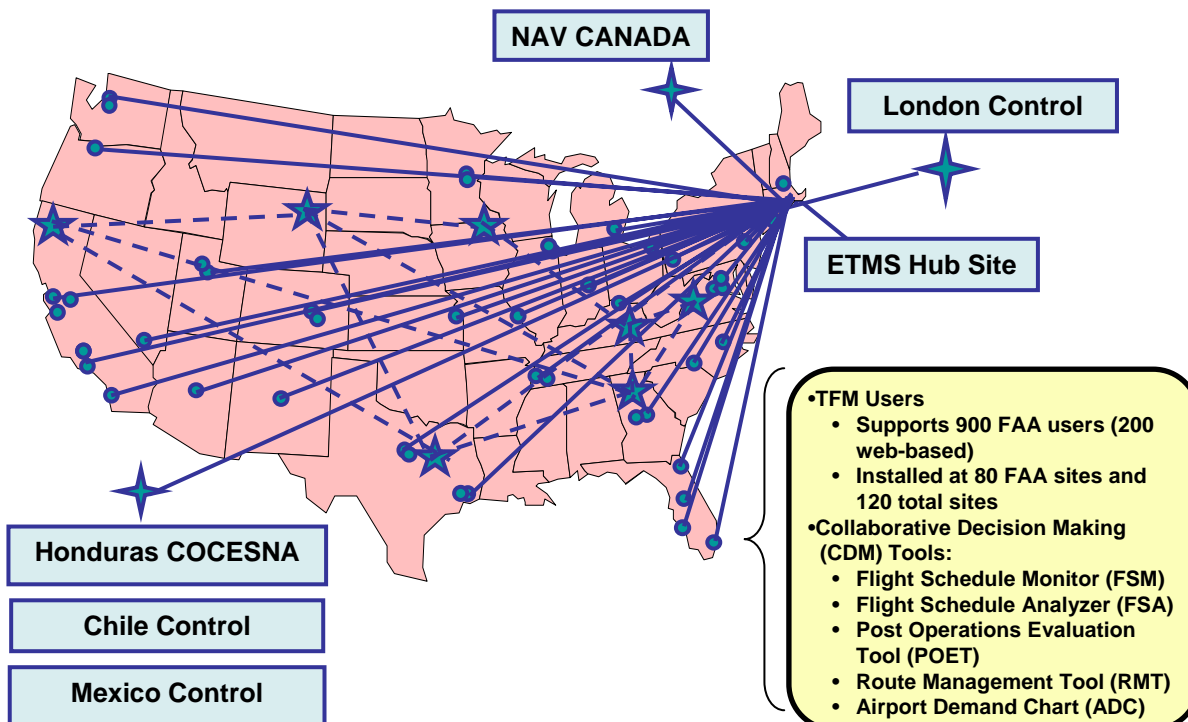
TFM Infrastructure

ATCSCC

ARTCC

Towers

Other

TFM Operational Locations and Service Delivery Points

- ATCSCC – Herndon, VA
- TFM Hub – Cambridge, MA
- Technical Center – FAA
- FAA HQ and Academy
- Contractor Sites (3)
- R&D (4)
- Traffic Management Units at:
  - ARTCCs (21)
  - TRACONs (33)
  - CERAPs (3)
  - Regional Offices (8)
  - Towers (11)
- Airlines (24)
- Military (11)
- International Sites (17)
- U.S. Government Locations (6)

NAV CANADA

London Control

ETMS Hub Site

Honduras COCESNA

Chile Control

Mexico Control

- TFM Users
  - Supports 900 FAA users (200 web-based)
  - Installed at 80 FAA sites and 120 total sites
- Collaborative Decision Making (CDM) Tools:
  - Flight Schedule Monitor (FSM)
  - Flight Schedule Analyzer (FSA)
  - Post Operations Evaluation Tool (POET)
  - Route Management Tool (RMT)
  - Airport Demand Chart (ADC)

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TFM Performance Gaps

- Infrastructure
  - Difficult to maintain and enhance current software
  - Difficult to integrate new capabilities from R&D community and other agencies

- Problem Determination
  - Demand forecasts are imprecise – critical data not being provided to TFM
  - Uncertainty in demand projections results in over-control of flights and under-utilization of NAS assets

- Evaluation of Alternative Traffic Management Initiatives
  - Cannot model alternative TMIs' impact on the NAS

- Solution Selection, Implementation, and Monitoring
  - Limited ability to grant user-preferred solutions
  - Inability to efficiently coordinate implementation with other domains

Current TFM infrastructure cannot affordably support these needs

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Program Definitions

- **Description of Problem:**
  - Software infrastructure limitations:
    - Based on 20-year-old code
    - Difficult to enhance
    - High cost of ownership
  - Many high-benefit functions are simply not feasible with current system
  - Performance gaps in predictability, inefficient delay and equity
- **Description of Solution:**
  - TFM-M will modernize the Enhanced Traffic Management System (ETMS) hardware and software
  - CATMT will add new capabilities to reduce NAS performance gaps, specifically to reduce over-control of flights, reduce unnecessary delays, and improve NAS predictability
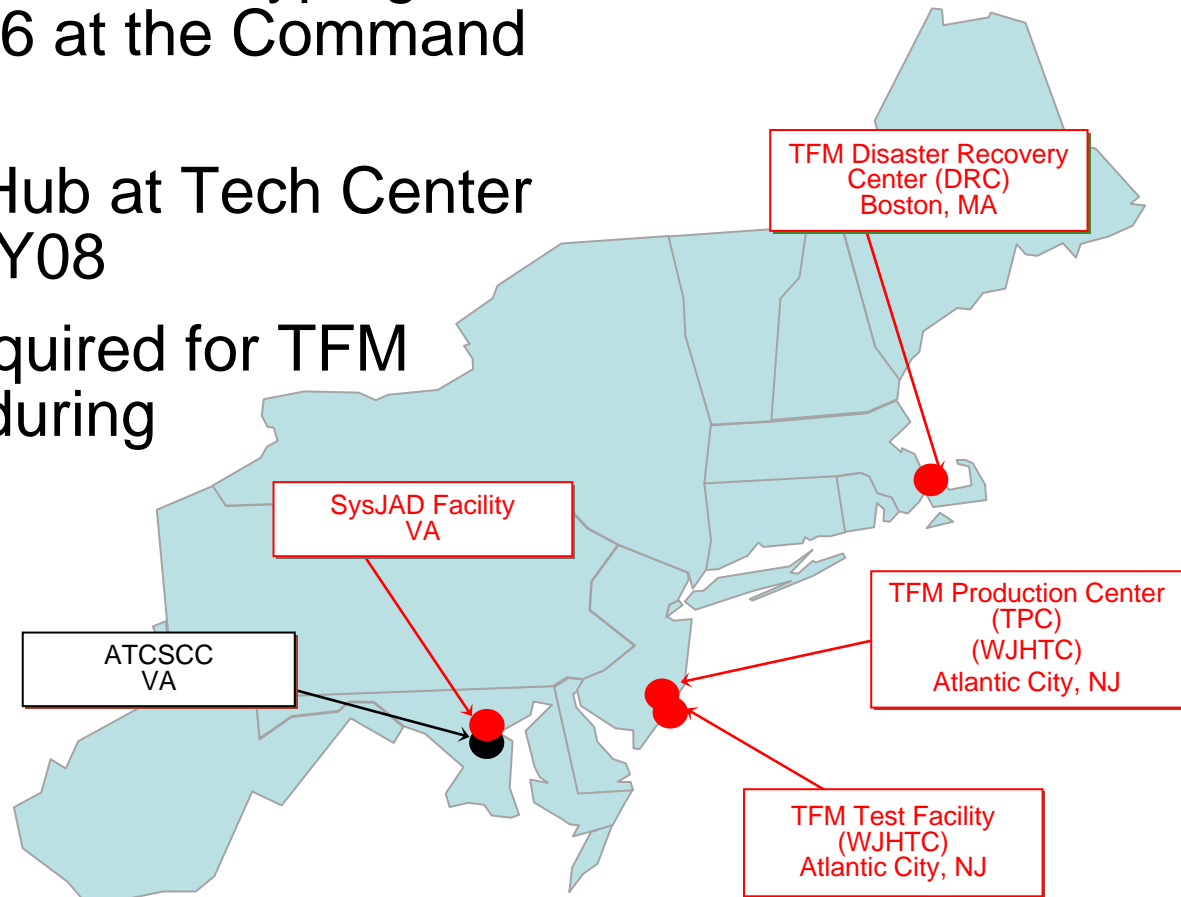
Key requirements and drivers for TFM include:
➢TFM-M: reducing operating and maintenance costs
➢CATMT: increasing efficiency of NAS operations

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TFM-M Plans

- Facility to support CHI Prototyping to be deployed in FY06 at the Command Center

- New TFM System Hub at Tech Center to be deployed in FY08

- Careful planning required for TFM tools and services during modernization

TFM Disaster Recovery Center (DRC) Boston, MA

SysJAD Facility VA

ATCSCC VA

TFM Production Center (TPC) (WJHTC) Atlantic City, NJ

TFM Test Facility (WJHTC) Atlantic City, NJ

TFM-M Goals

- Establish an open-architecture platform – with robust framework for implementing enhancements & operational improvements
- Increase development bandwidth for maintainers, prototypers – support reduction of backlog of new functions; facilitate involvement of 3rd party R&D groups
- Facilitate integration with other domains
- Reduce Total Cost of Ownership
- Improve TFM performance, capacity and human-computer interface
- Provide scalability to address increased traffic load and complexity without architecture change
- Support effective collaboration and integrated TM

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Relationship of TFM-M & CATMT

- TFM-M will provide the infrastructure to address operational, infrastructure/architectural, cross-domain, and security needs

- CATMT will develop the new capabilities to provide the benefits of increased productivity and efficiency.

- Traffic managers need capabilities to support all aspects of TFM, including:
  - Flight planning
  - Monitoring demand and capacity
  - Problem determination and strategy development
  - Execution and exit strategy
  - Post evaluation
  - Cross-domain integration

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CATMT WP1 Components

Reroute IA and Resolution
Predict demand on NAS resources and assess the time/distance impact on flights due to a single proposed reroute strategy.

MIT IA and Resolution
Provide demand prediction capability that includes existing MITs. Similar to Reroute IA technique applied to MIT initiatives.

Airspace Flow Program (AFP)
Standard GDP procedures used to reduce demand on a flow constrained area (FCA). Replaces GDP-SWAP.

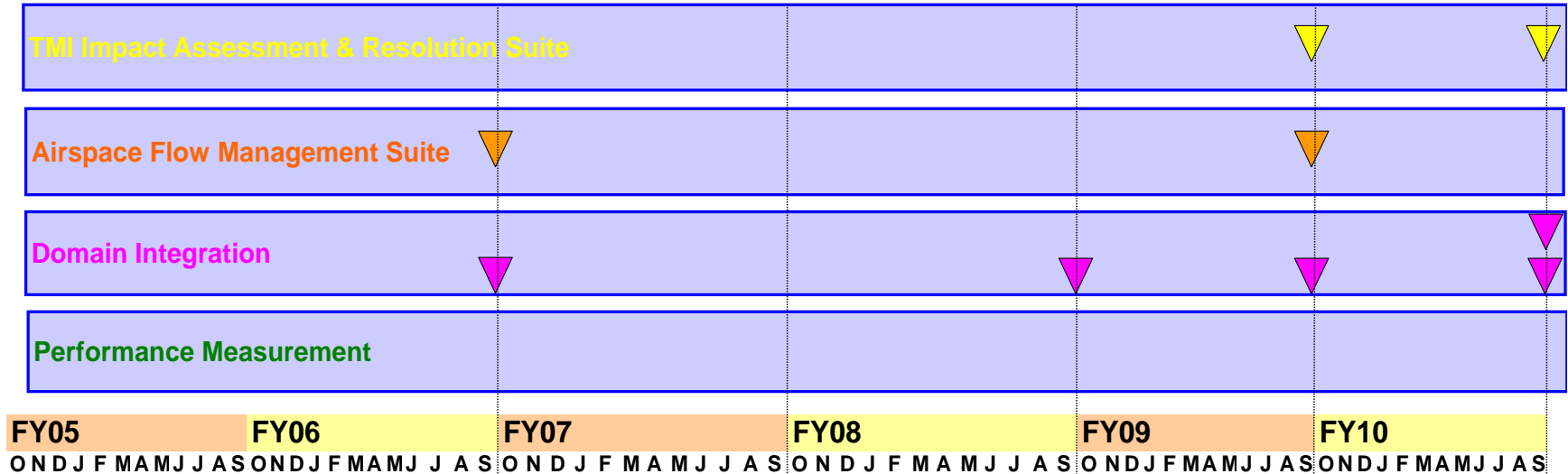**Full-scale AFP with User Preferences**
Flight-specific routes are chosen by an FAA resource allocation algorithm that takes air carrier preferences into account. NAS users have maximum flexibility in selecting routing options.

Surface Data
ASDE-X/EFSTS data from 4 Site Groups

Execution of Flow Strategies
Distribution of FP change info when implementing a Reroute TMI

TMI Impact Assessment & Resolution Suite

Airspace Flow Management Suite

Domain Integration

Performance Measurement

FY05	FY06	FY07	FY08	FY09	FY10
O N D J F M A M J J A S	O N D J F M A M J J A S	O N D J F M A M J J A S	O N D J F M A M J J A S	O N D J F M A M J J A S	O N D J F M A M J J A S

Using Simulation: Before Implementing a TFM Enhancement

- Used simulation to estimate benefits of proposed enhancements during the Investment Analysis (IA) process for TFM-M and CATMT
- Used MITRE CAASD's Probabilistic, Automation-Assisted En Route Congestion Management (PACER) prototype tool
- Simulations were run to estimate benefits for:
  - MIT Impact Assessment & Resolution
  - Reroute Impact Assessment & Resolution

Using Simulation: During a TFM Enhancement

- MIT IAR and Reroute IAR capabilities use simulation to predict the impact of an MIT, a reroute, or a combination of these initiatives

- These "what-if" analyses will allow Traffic Managers to prevent or resolve a predicted capacity overload when considering a TMI

MIT Impact Assessment & Resolution

Problem Statement

The same level of Miles-in-Trail (MIT) are often imposed at the same time every day. This causes flights to be over controlled and causes unnecessary delays. There is no modeling capability to assess the overall impact of MIT restrictions. Traffic managers must rely on experience to determine if MITs will prevent or resolve a predicted capacity overload, or possibly create an unexpected capacity overload at another location. The inability to assess the impact of MITs creates demand uncertainty and often results in unnecessary delays.

Proposed Solution

The **MIT Impact Assessment & Resolution** capability will model various scenarios taking users' intent into consideration, assess the impact on NAS resources and NAS users, and find the most efficient TMI that is effective with the least impact. Traffic managers will be able to determine if the proposed MIT restriction will resolve the capacity overload without creating any other problems.

Graphical NAS MIT Display

Benefits

• Traffic managers will be able to establish MIT restrictions for shorter durations and/or with less restrictive spacing values

• MITs should affect fewer flights, often with reduced impact on affected flights.

• Increased confidence in MITs when used

# Reroute Impact Assessment & Resolution

Problem Statement

Current reroute planning activities include identification of a constraint, telephonic collaboration, manual selection of reroutes and extensive negotiations. All of these steps are completed utilizing anecdotal or experiential data. Decision support automation to enhance this process is currently non-existent. The process is cumbersome and the results of the proposed reroutes are often uncertain.

Proposed Solution

The **Reroute Impact Assessment & Resolution** capability will help Traffic Managers analyze
system-wide problems, particularly those problems caused by congestion of NAS Airspace. This capability will allow traffic managers to perform "what if" analyses for proposed reroutes to determine the possible impact to the NAS prior to implementation.

Benefits

- Helps generate more efficient reroute solutions to reduce customer cost/flight time
- Helps traffic managers understand the impacts of the reroutes being proposed, so they can judge whether the reroutes are operationally acceptable. Results in more efficient reroutes
- Reduces time between decision and implementation for a reroute

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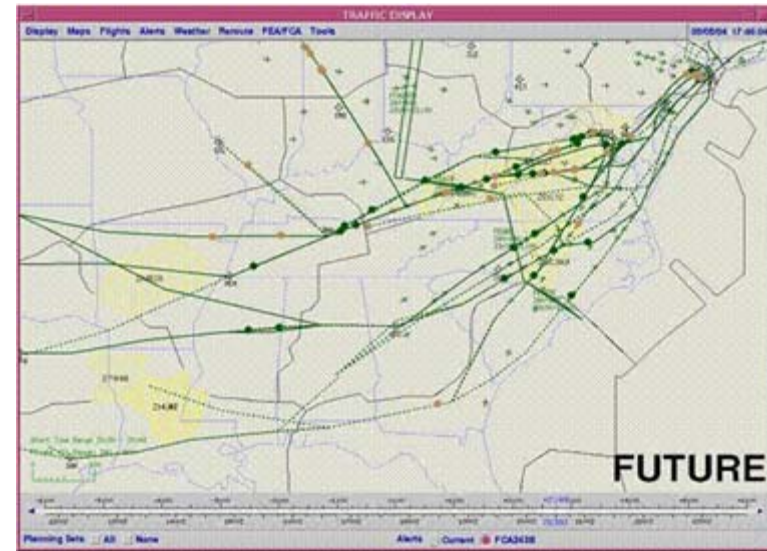
Using Simulation: After a TFM Enhancement

- Quantifying the benefits of the actions we take is a challenge
- Simulation could help us quantify the savings of:
    - what actually happened due to an initiative, versus
    - what would have happened in the absence of an initiative
- We need to measure and constantly improve the efficiency of our operation
- This is an opportunity for additional uses of simulation in the future

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International Collaboration

- Eurocontrol CDM Taskforce meeting in Brussels: 29 Nov
  - FAA participation on data sharing with industry
- FAA coordination with initiation of central flow facility in Japan
- FAA coordination with central flow facility in Mexico City

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Backup

RR IAR Simulation: PACER (Simulation used before implementation)

- In order to show the benefits of Reroute Impact Assessment, two scenarios were modeled (a baseline and an alternate) using a prototype tool called Probabilistic, Automation-Assisted En Route Congestion Management (PACER). The PACER prototype is being developed to explore Traffic Flow Management (TFM) decision support for predicting and managing traffic congestion and weather-impacted airspace. This prototype can resolve congestion problems by proposing custom reroutes and delays for flights that are scheduled to encounter congestion or flow constrained areas. Flight reroutes are either taken from a database of acceptable routes such as the Coded Departure Routes (CDRs), or from route corridors that specify acceptable routes around problem areas. Resolution algorithms take into account uncertainties in predicting congestion, using probabilistic metrics to decide how much intervention is required to achieve a reasonable solution.

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RR IAR Simulation: PACER (Simulation used before implementation), cont.

- The bottom-up approach modeled two scenarios per severe-weather day: a baseline and an alternate. To perform the modeling, a prototype tool called Probabilistic, Automation-Assisted En Route Congestion Management (PACER) is used as a simulation environment. PACER accepts, as input, weather and traffic definitions, and allows the user to draw avoidance polygons and try "what-if" solutions involving alternate routing and delay. For our uses in this project, the PACER prototype simulation model was used to create a baseline scenario to represent current-day operations. Rerouting around weather involved "playbooks" for strategic rerouting, and "corridors" (i.e., hand-constructed routes which barely skirted the weather polygons) for tactical routing. An alternate scenario solved the same rerouting scenario, but used the feature of "finely-tailored re-routes" assumed to be in RRIA. To represent that feature, a database of all known Coded Departure Routes (CDRs) was considered for potential strategic reroutes. Also considered were the "corridors" constructed for the baseline run, for tactical rerouting.

- For the baseline runs, flights requiring reroutes were assigned to playbook plays as an initial step. Other flights were then rerouted using the PACER logic. PACER used a combination of routing onto corridors, and ground delay to ensure that (1) no flights intersected the weather and (2) sector capacities were not exceeded. PACER is not capable of modeling flight cancellations and diversions.

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Airspace Flow Program (AFP)

Problem Statement

A number of procedures are used to handle airspace congestion, including miles-in-trail (MIT), Flow Constrained Areas (FCAs), reroutes, and GDPs. These methods are sometimes inefficient and inequitable, often leading to over-control of flights. This is particularly true of multiple GDPs in support of SWAP.


Proposed Solution

The **Airspace Flow Program** capability is currently being developed. The approach is to merge GDP rationing algorithms with FCA

airspace depiction and flight list generation. This allows for formal control times to be issued to flights traversing a congested volume of airspace while more accurately defining which flights need to be controlled. Phase I of AFP will deploy Airspace-based GDPs. Phase 2 release will integrate Airspace-based GDP with Constraint Resolution Intent (CRI), and Phase 3 will add support for Multiple Flight Plans.

Benefits

• Reduces over-control of flights. Eliminates delay currently imposed on "innocent" flights
• Offers NAS Users the choice to accept a ground delay, or reroute around a constraint area
• Applies restrictions directly to the resource with reduced capacity. Fewer flights constrained by GDPs
• Eliminates multiple GDPs in support of SWAP
• Supports equitable management of En Route airspace
• Reduces TMC Workload: one AFP to manage vs. multiple GDPs

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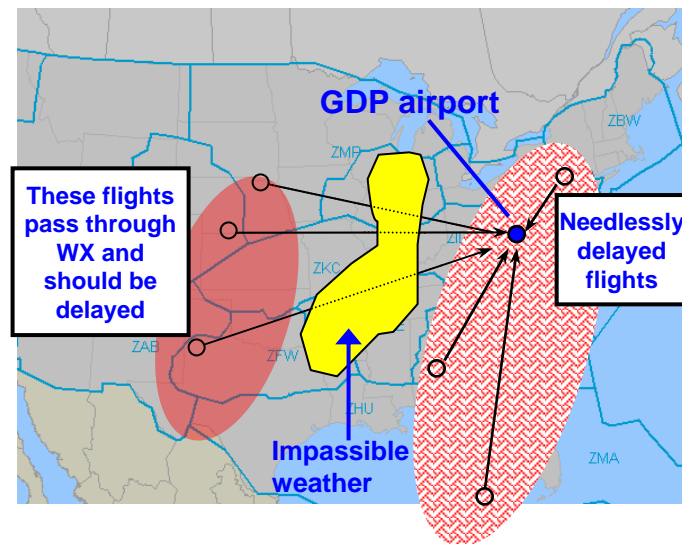
Integration of Surface Data
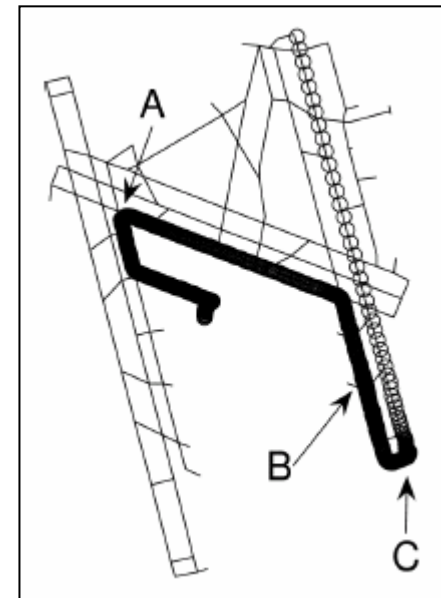
Problem Statement

In order to make decisions that lead to an efficient operation in the NAS, traffic managers pull and integrate data from a variety of sources. One area where data has traditionally been lacking is the airport surface. Due to this gap in information, ATO System Operations has initiated a program to prototype the integration of surface data into Traffic Flow Management.

Proposed Solution

Integration of Surface Data will integrate ASDE-X, EFSTS and possibly other data into TFM. Initially, surface data will be extracted from two airports. Future year deployments will be expanded as additional surface data sites become available.

Benefits

- Provides more accurate predictions: Improved departure prediction times will lead to more precise downstream predictions for Monitor Alert, FEAs/FCAs, arrivals, etc. to help maximize NAS efficiency and capacity
- Reduced workload due to more accurate data
- Provides more accurate information for NAS Users' planning purposes – departure times, arrival times, gate availability, connections, etc.

Integrated Collaborative Routing

Problem Statement

Defining and issuing reroutes to avoid potential weather and en route congestion problems is one of the methods available for traffic flow management in the NAS. Currently, the FAA is often incapable of considering a flight's preferences when issuing reroutes. The same reroute is applied to all flights departing from a specified ARTCC's airspace. Flights can have their path changed significantly, resulting in higher costs and travel times, and possibly extended delays if flights need to take on additional fuel prior to departure.

Proposed Solution

Integrated Collaborative Routing (ICR) builds on the existing capabilities
of FEAs/FCAs while integrating new concepts and capabilities. ICR currently consists
of two functions:

1) Constraint Resolution Intent (CRI) which allows NAS Users to submit an
alternate flight plan or preferred solution for a constraint

2) Reroute Modeling which allows NAS Users to assess the impact of a
proposed alternative flight plan

Together, ICR will greatly improve rerouting capabilities in the NAS.

Benefits

- Increases flexibility of NAS Users in selection of reroutes
- Potentially reduces cost/time impact of reroutes
- Facilitates more flexible responses to NAS capacity constraints
- Allows Traffic Managers to see the potential results of proposed programs before issuing them
- Allows Traffic Managers more time to focus on the reroute program and its results rather than finding/picking routes for flights
- Shared Modeling results improve common situational awareness for all stakeholders

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Execution of Flow Strategies (EFS)

Problem Statement

The existing infrastructure is a patchwork of manual and automated capabilities, requiring multiple and sometimes duplicate actions. There is little automation capability to assist FAA traffic flow managers, air traffic personnel, and NAS Users in the implementation, distribution and monitoring of traffic flow strategies. A traffic flow strategy, developed in response to an actual or predicted resource demand/capacity imbalance or severe weather, may require coordination and collaboration among multiple organizations and facilities with varying automation capabilities.

Proposed Solution
Execution of Flow Strategies will:
1) generate proposed flight plan amendments for pre-departure flights and distribute them to ERAM
2) generate ERAM-acceptable reroute amendments for pre-departure and airborne flights and distribute them to traffic managers and NAS Users.

Benefits
- Reduction in number of flight cancellations and flight amendments
- Reduction in time required to execute traffic management initiatives, and thus potentially reduced delays
- Reduction in time required to exit traffic management initiative programs; e.g., restart airport departures at conclusion of GDP
- Reduction in workload required to enter flight plans, reroutes, amendments, etc.
- Increased flexibility due to quicker response to changes in programs or desired reroutes
- In general, all programs will benefit from improved execution – "it's the process, not the tool"
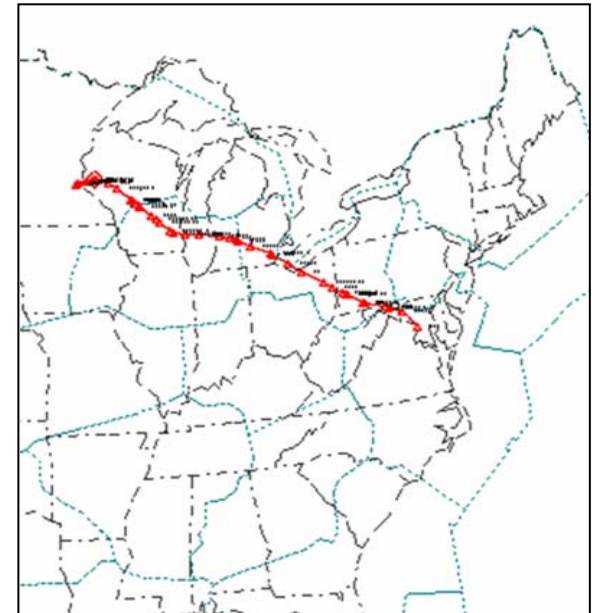
Performance Measurement: Analysis

Problem Statement

Generating reports to characterize and summarize NAS Performance is currently a semi-automated process, that depends in part on the manual manipulation of multiple databases throughout the TFM System. This manipulation of databases requires thousands of FAA staff-hours per year. In addition, the current TFM software has limited "instrumentation" to support collection of data that will support the analysis required to determine progress toward meeting NAS performance targets.

Proposed Solution

A key part of the TFM modernization activity is the development of centralized relational databases that will replace the numerous "flat files" presently distributed throughout TFM software subsystems. In addition, each new capability developed in the CATMT Program will include instrumentation embedded in the deployed software code for data collection that will support post-processing and data analysis.

Benefits

• Centralized data repositories will improve overall data accuracy and reliability

• Increased data collection will provide the means for NAS users and the FAA to conduct more robust analysis of system operations, to monitor progress toward desired system efficiency and effectiveness

• Will provide data necessary for future investment analyses

Growth in User Demand for TFM Services

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